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फेरस पाइप और नलियों के चुम्बकीय कण दोष निकालने की रीति संहिता

(दूसरा पुनरीक्षण)

Code of Practice for Magnetic Particle Flaw Detection of Ferrous Pipes and Tubes

(Second Revision)

ICS 77.040.20; 77.140.30

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Non-destructive Testing Sectional Committee, MTD 21

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Non-destructive Testing Sectional Committee, had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1972 and subsequently revised in 1991. This revision has been prepared taking into account the latest technological developments on the subject. In this revision following modifications have been made :

a) In clause **7** Methods of magnetization have been simplified. Magnetizations by prod and yoke have been added.
b) In clause **8** Field strength calculation for longitudinal magnetizations coil have been added in tabular form.
c) In clause **8** figure has been added for better understanding.
d) In clause **10** Viewing condition has been modified.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off values should be the same as that of the specified value in this standard.

Indian Standard

CODE OF PRACTICE FOR MAGNETIC PARTICLE FLAW DETECTION OF FERROUS PIPES AND TUBES

(Second Revision)

1 SCOPE

1.1 This standard covers magnetic particle methods for the detection of flaws in both seamless and welded ferrous pipes and tubes having an outside diameter of not less than 3 mm. It does not apply to the detection of flaws in pipes and tubes of non–ferromagnetic materials, for example, austenitic stainless steel.

1.2 This standard is primarily applicable to magnetic particle inspection for detection of surface and subsurface flaws in the pipe and tube.

1.2.1 This standard should not be used for detection of flaws below the surface unless it can be shown that such flaws are capable of being detected by the method and the equipment to be used, and there is agreement between the contracting parties.

1.3 This standard does not lay down any stipulation for acceptance or rejection of pipe and tube on which flaws have been detected. This shall be subject to agreement between the contracting parties.

1.4 This method of testing shall not be used in cases where even slightest residual magnetism are not allowed from the functional point of view of the product.

NOTE — For the purpose of this standard, no difference is intended in the meaning of words ‘pipe’ and ‘tube’.

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

IS No.	*Title*
3415 : 1998	Glossary of terms used in magnetic particle flaw detection (*second revision*)
3703 : 2004	Code of practice for magnetic particle flaw detection (*second revision*)
6410 : 1991	Specification for magnetic flaw detection inks and powders (*first revision*)

3 TERMINOLOGY

For the purpose of this standard the terms and definitions given in IS 3415 and IS 3703 shall apply.

4 SURFACE CONDITIONS

All surfaces shall be free from such scale, dirt, grease, paint and other foreign matter as will interfere with the interpretation of the test. The methods used for cleaning and preparing the surfaces for magnetic particle inspection shall not be detrimental to the material, the surface finish or the inspection media.

5 INSPECTION MEDIA

5.1 For the purpose of this standard, inspection media are classified in the following groups:

a) *Group* 1 — Dry powders in which the magnetic particles are applied without the use of a carrier liquid.

b) *Group* 2 — Wet particles in which a particle concentrate is diluted using a carrier liquid.

   1) Colour contrast type, and
   2) Fluorescent type.

c) *Group* 3 — Magnetic inks which are either in ready to use dilution in a carrier liquid for ready to use concentration or in the form of concentrated liquid suspension (which are to be diluted before use).

   1) Colour contrast type, and
   2) Fluorescent type.

NOTE — Contrast aids may be employed with all the three groups.

5.2 The dry powders (Group 1), wet particles (Group 2) and the inks (Group 3) shall satisfy the requirements laid down in IS 6410.

5.3 The ink Group 3 (1) and (2) shall be checked at frequent intervals. When the ink becomes discoloured or contaminated with foreign matter to the extent that

proper distribution and concentration of the ink or the intensity, character or definition of the magnetic particles are impaired, it shall be discarded and replaced with fresh ink.

6 TESTING EQUIPMENT

6.1 The testing equipment shall be capable of inducing and maintaining an adequate magnetic flux in the pipe or tube under inspection, the path of the magnetic flux being substantially at right angles to the principal axes of imperfections being sought. Means shall be provided to measure the current or the magnetic field strength and the detectability of flaws established using artificial defect standards.

6.2 The magnetic flux shall be produced in the pipe or the tube by one or more of the methods given in **6**, so that the magnetization is done in a minimum of two mutually perpendicular directions.

7 METHODS OF MAGNETIZATION

7.1 One or more of the following methods of magnetization shall be used:

a) Current Flow Method (Direct Circular Magnetization),
b) Central Conductor Circular Magnetization,
c) Offset Central Conductor Circular Magnetization,
d) Circular Magnetization by Prod Method,
e) Longitudinal Magnetization by Coil, and
f) Longitudinal Magnetization by Yoke.

8 MAGNETIZING CURRENT

8.1 Current Flow Method (Direct Circular Magnetization)

When current flows through the pipes or a tube, satisfactory magnetization may be obtained by passing direct or half wave rectified current as follows:

a) For tubes or pipes with outer diameter up to 125 mm — 28 to 36 amperes/mm of diameter,
b) For tubes or pipes with outer diameter over 125 mm up to 250 mm — 20 to 28 amperes/mm of diameter,
c) For tubes or pipes with outer diameter over 250 mm up to 375 mm — 12 to 20 amperes/mm of diameter, and
d) For tubes or pipes with outer diameter over 375 mm — 4 to 12 amperes/mm of diameter.

Alternating magnetizing current can be used at approximately half of these values for detection of surface discontinuities.

8.2 Central Conductor Circular Magnetization

Circular magnetization can be provided by placing a current carrying central conductor inside the pipe. When the axis of the current carrying conductor coincides with the central axis of the pipe current levels as given in **8.1** can be applied.

If the purpose of the test is to detect discontinuities on the inside surface of the pipe then the current should be calculated considering diameter as greatest distance between two points 180° apart on inside circumferential arc.

8.3 Offset Central Conductor Circular Magnetization

In this method the inside current carrying central conductor is placed on the inside wall of the pipe. The effective diameter is calculated as the sum of the diameter of central conductor plus twice the wall thickness of the part. The current levels as mentioned in **8.1** can be applied. The effective circumferential arc that can be examined should be 4 times the diameter of the central conductor. It is recommended to test the entire circumference of the pipe by rotating it on the conductor or *vice versa* with 10 percent overlap.

Effective area of inspection while using offset central conductor is equal to four times the diameter of central conductor as denoted by circumferential arc in Fig. 1.

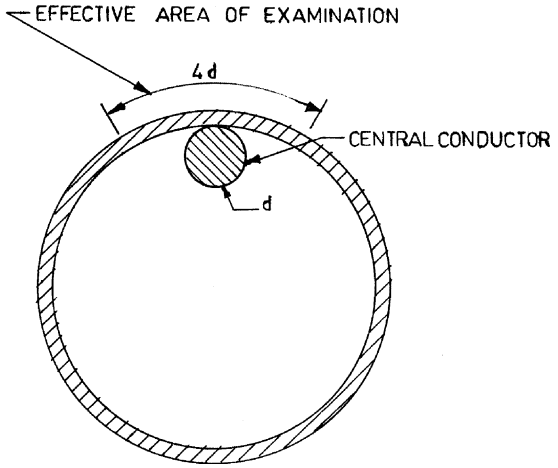


FIG. 1 EFFECTIVE AREA OF INSPECTION

8.4 Circular Magnetization by Prod Method

For Prod method, the distance between the prods is generally maintained between 100 to 200 mm. For pipes with wall thickness less than 20 mm the current requirement is in the range 90 to 110 amperes per 25 mm of prod distance. For pipes with wall thickness greater than 20 mm the current requirement is in the range of 100 to 125 amperes per 25 mm of prod distance.

8.5 Longitudinal Magnetization by Coil

The field strength (*see* Table 1) in a pipe being magnetized in a coil is determined by the ampere-turn of the coil and the length (L) to diameter (D) ratio of the object.

8.6 Longitudinal Magnetization by Yoke

Longitudinal magnetization can be obtained by yoke in a localized area. The longitudinal field is formed between the poles. The electromagnetic yokes have fixed or articulated legs. Normally two separate examinations should be carried out on each area.

During second examination the lines of magnetic flux should be approximately perpendicular to those during first examination. The inspection area should be restricted to distance of one quarter of pole spacing on either side of line joining two poles. Overlapping of pole spacing should be at least 25 mm. When using alternating current the yokes should have lifting force of 4.5 kg with pole spacing of 50 mm to 150 mm. When using direct current yokes should have lifting force of 13.5 kg with 50 mm to 100 mm spacing between poles and 22.5 kg with 100 mm to 150 mm spacing of poles.

8.7 The flaw detectability in all the above cases may be ascertained using suitable artificial defect standards.

9 TESTING PROCEDURE

9.1 The pipe or tube to be inspected shall be magnetized by one or more of the methods given in **7.1**.

9.2 Pipes or tubes having any residual magnetism, shall be demagnetized prior to test.

9.3 The surface to be examined shall be uniformly coated with magnetic particles. The coating may be applied by immersion, flooding, brushing, spraying or dusting either immediately prior to or during magnetization.

9.4 Subject to agreement, the magnetic particles may be applied after magnetization when the residual magnetism in the material is utilized.

9.5 Except in the case of surge magnetization and residual method, the current used for magnetization shall be maintained continuously over the period of particle application and drainage of excess particle/ blowing off of the excess dry powder.

9.6 Visual examination of magnetic particle pattern on the surface of the pipe or tube shall then be made immediately under appropriate viewing conditions (*see* **10**)

Table 1 Calculation of the Field Strength in a Magnetized Pipe

(*Clause* 8.5)

Sl No.	Fill Factor	Position of Object	Field Strength (NI) Ampere Turns (±10%)
i)	Low	Near/close to inside surface of coil	$\frac{45\,000}{L/D}$
ii)	Low	At the centre of the coil	$\frac{1\,690\,R}{(6\,L/D)-5}$
iii)	Intermediate	Cross-section of the coil > twice and < 10 times the cross-section area of the pipe	$\frac{(NI)\,h\,(10-a)+(NI)l(a-2)}{8}$
iv)	High	Cross-section area of the coil < twice cross-section area of the object	$\frac{35\,000}{(L/D)+2}$

Here I = current supplied to magnetizing coil (in amp).

$(NI)\,h$ = field strength, High using formula (iv).

$(NI)\,l$ = field strength, Low using formula (i) or (ii).

N = number of turn of coil.

L = length of the pipe in mm.

D = diameter of the pipe in mm.

R = radius of the coil in mm.

α = ratio of the cross-section area of the coil to the cross-section area of pipe

$$D = \sqrt{\left[(OD)^2-(ID)^2\right]}$$

where

OD = outside diameter of the pipe, and

ID = inside diameter of the pipe.

9.7 A surface which has been treated with (colour contrast type) magnetic ink (Group 3) shall not be subsequently processed using fluorescent ink (Group 3) or fluorescent particle [Group 2(2)] since the former may possibly quench the fluorescence.

9.8 Pipes or tubes which exhibit residual magnetism shall be demagnetized on completion of the test (*see* **8** of IS 3703). The techniques of demagnetization and the level of residual magnetic field left after demagnetization shall be mutually agreed between purchaser and the supplier.

10 VIEWING CONDITION

10.1 When colour contrast type particles are used, the area under inspection shall be adequately illuminated to a minimum intensity of 1 000 lux on the test surface to enable proper evaluation of indications revealed on the test surface.

10.2 The examination with fluorescent particles using black light shall be performed in a darkened area where ambient visible light intensity should not be more than 20 lux measured at the part surface. The intensity of black light at the surface being examined should be minimum of 1 000 $\mu W/cm^2$. The intensity of black light should be checked at regular intervals as mutually agreed between the contracting parties.

11 INTERPRETATION OF RESULTS

11.1 Indications revealed by this method shall be evaluated in accordance with an agreement level of acceptance.

11.2 All indications revealed by this method do not necessarily represent flaws since non relevant indications as indicated in IS 3703 may be encountered. Indications believed to be non-relevant shall be explored by visual or other methods and if necessary, the test surface shall be cleaned and re-inspected. After testing components shall be cleaned to remove all traces of detecting ink, contrast aid, if used and temporary marking, if applied. This may be carried out by wiping or washing with solvent like white spirit, or by complete immersion in an approved degreasing agent.

12 REPORTING OF RESULTS

12.1 The results of magnetic particle flaw detection shall be recorded and shall include the following information:

a) Date of test,
b) Job identification reference,
c) Identity of person responsible for the test,
d) Inspection media used,
e) Method of magnetization and current/ magnetic field strength, and
f) Description and location of all flaws with sketch wherever possible.

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